NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety

Washington, D.C. 20594

LATERAL ACCELERATIONS AT CG AND TIP TANK

A. ACCIDENT

Location: Troy, MI
Date: September 24, 2009
Aircraft: N4864S PA32-260 C
NTSB#: CEN09LA605

The lateral accelerations at the tip tank or the time to complete a 90 degree turn were calculated using Math Cad.

GPS data show that the speed at the turn was likely about 9 mph. Calculations also show that a lateral acceleration to unport the left tip tank with 4.5 gallons of fuel would need to reach 0.374 Gs.

The lateral acceleration the CG was varied to produce either a 0.374 G lateral acceleration at the tip tank or a 4-second, 90-degree turn at 9 mph.

A lateral acceleration of 0.18 G at the CG would result in a lateral acceleration of 0.372 Gs at the wing tip. However, the time to complete the 90-degree turn would be about 1.8 seconds. The unporting time would be less than the 1.8 seconds required to complete the turn.

A lateral acceleration of 0.08 G at the CG would require about 4 seconds in order to complete the turn. However the lateral acceleration would be about 0.12 G at the wing tip, not sufficient to unport the tank.

LATERAL ACCELERATION AT LEFT TIP TANK

The IIC replaced 4.5 gallons of fuel in the left tip tank. Starting with the tank oriented con with the airplane in level attitude and rotated to account for dihedral, he rotated the tank le wing down until the outlet port unported. That occured at 20.5 degrees. The lateral acceleration required to unport in flight or on the ground is tan(rotation angle):

$PHI := \frac{20.5}{57.3}$ $G\_TIP := \tan(PHI)$ $G\_TIP = 0.374$ G where G=a/g and g=32.2 fps^2

GPS data suggest that the 90-degree turn was completed at 9 mph in about 4 seconds. On ground, the right turning rate to align with the runway would produce a lateral acceleratic the CG and a greater lateral acceleration at the wing tip. The following calculations assume a 9-mph speed based on GPS data and show the time and lateral acceleration at the CG and tip to turn 90 degrees.

$VMPH := 9$ TAXI SPEED

$VFPS := VMPH \cdot 1.46666$ $VFPS = 13.2$ $\Pi := 3.14$

$B := 32$ WING SPAN

$DELRT := \frac{B}{2}$ $DELRT = 16$ DISTANCE FROM CG TO TIP

$gCG := .18$ LATERAL ACCELERATION AT CG

$RCG := \frac{VFPS^2}{2 \cdot 32.2 \cdot gCG}$ $RCG = 15.031$ RADIUS OF TURN AT CG

$C\_TURN := \left(\frac{2\Pi \cdot RCG}{4}\right)$ $C\_TURN = 23.599$ CIRCUMFRENCE OF 90 DEG TURN

$T\_TURN := \frac{C\_TURN}{VFPS}$ $T\_TURN = 1.788$ TIMESEC TO TURN 90 DEGREES

$R\_TIP := RCG + DELRT$ $R\_TIP = 31.031$ RADIUS OF TURN AT TIP

$C\_TIP := \left(\frac{2\Pi \cdot R\_TIP}{4}\right)$ $C\_TIP = 48.719$ $V\_TIP := \frac{C\_TIP}{T\_TURN}$ $V\_TIP = 27.251$

$g\_TIP := \frac{V\_TIP^2}{2 \cdot 32.2 \cdot R\_TIP}$ $g\_TIP = 0.372$

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$PHI := \frac{20.5}{57.3}$ $G\_TIP := \tan(PHI)$ $G\_TIP = 0.374$ G where G=a/g and g=32.2 fps^2

GPS data suggest that the 90-degree turn was completed at 9 mph in about 4 seconds. On ground, the right turning rate to align with the runway would produce a lateral acceleratic the CG and a greater lateral acceleration at the wing tip. The following calculations assume a 9-mph speed based on GPS data and show the time and lateral acceleration at the CG and tip to turn 90 degrees.

$VMPH := 9$ TAXI SPEED

$VFPS := VMPH \cdot 1.46666$ $VFPS = 13.2$ $\Pi := 3.14$

$B := 32$ WING SPAN

$DELRT := \frac{B}{2}$ $DELRT = 16$ DISTANCE FROM CG TO TIP

$gCG := .08$ LATERAL ACCELERATION AT CG

$RCG := \frac{VFPS^2}{2 \cdot 32.2 \cdot gCG}$ $RCG = 33.82$ RADIUS OF TURN AT CG

$C\_TURN := \left(\frac{2\Pi \cdot RCG}{4}\right)$ $C\_TURN = 53.097$ CIRCUMFRENCE OF 90 DEG TURN

$T\_TURN := \frac{C\_TURN}{VFPS}$ $T\_TURN = 4.022$ TIMESEC TO TURN 90 DEGREES

$R\_TIP := RCG + DELRT$ $R\_TIP = 49.82$ RADIUS OF TURN AT TIP

$C\_TIP := \left(\frac{2\Pi \cdot R\_TIP}{4}\right)$ $C\_TIP = 78.217$ $V\_TIP := \frac{C\_TIP}{T\_TURN}$ $V\_TIP = 19.445$

$g\_TIP := \frac{V\_TIP^2}{2 \cdot 32.2 \cdot R\_TIP}$ $g\_TIP = 0.118$